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been printed in pamphlet form at Washington, D. C. They are: "On the cardioids fulfilling certain assigned conditions" (44 pages) by Sister Mary Gervase, and "On the in-and-circumscribed triangles of the plane rational quartic curve" (31 pages) by Joseph Nelson Rice.

PROBLEMS FOR SOLUTION.

SEND ALL COMMUNICATIONS ABOUT PROBLEMS AND SOLUTIONS TO B. F. FINKEL, Springfield, Mo.

2699. Proposed by ROGER E. MOORE, University of Wisconsin.

Show that if $a_k^{(r)}$ denotes the kth term of an arithmetic progression of order r, and c_k denotes the kth binomial coefficient in the expansion of $(a - b)^n$, n being a positive integer,

$$s \equiv \sum_{k=1}^{n+1} c_k a_k^{(r)} = 0, \qquad \text{if} \qquad n > r.$$

2700. Proposed by ARTEMAS MARTIN, Washington, D. C.

In a factory 250 men are paid an average wage of \$15 each per week. The men are paid unequally, the wages being \$20, \$16, \$10 and \$8 per week, respectively, for different classes of work. How many are employed at each rate of pay?

NOTE. I am told that this question was set in a Civil Service Examination Paper to be worked by Arithmetic. 2,896 answers have been found. Are there any more?

2701. Proposed by EDWARD H. WORTHINGTON, University of Pennsylvania.

Find the sum of the infinite series

$$\frac{1}{5} + \frac{1\cdot 2}{5\cdot 7}r + \frac{1\cdot 2\cdot 3}{5\cdot 7\cdot 9}r^2 + \cdots + \frac{n!}{5\cdot 7\cdot 9\cdots(2n+3)}r^{n-1} + \cdots.$$

Verify your result for $r = 0$ and $r = 1$.

2702. Proposed by N. P. PANDYA, Sojitra, India.

A conic of variable eccentricity has a focus and corresponding directrix fixed. The latus rectum cuts a fixed circle in A' and B'. If A be the vertex of the conic, find the locus of the centroid of the triangle $AA'B'$.

2703. Proposed by S. A. COREY, Albia, Iowa.

Let A_1, A_2, A_3, A_4, and $-(A_1 + A_2 + A_3 + A_4)$ be the vector sides of a pentagon, plane or gauche. Let B_1, B_2, B_3, B_4, and $-(B_1 + B_2 + B_3 + B_4)$ be the sides of a second pentagon, where

$$B_1 = (c_1 + c_2)A_1 + (c_1 - c_2)A_3,$$
$$B_2 = (c_4 + c_3)A_4 + (c_4 - c_3)A_2,$$
$$B_3 = (c_2 + c_1)A_2 + (c_2 - c_1)A_4,$$
$$B_4 = (c_3 + c_4)A_3 + (c_3 - c_4)A_1,$$

c_1, c_2, c_3, and c_4 being ordinary scalars.

Then, if a_r and b_s are the lengths of the sides A_r and B_s, respectively, and if $\cos A_rA_s$ = cosine of the angle included between the sides A_r and A_s, and if $\cos B_rB_s$ = cosine of the angle included between the sides B_r and B_s, prove that

$$2(c_1c_4 + c_2c_3)(a_1a_4 \cos A_1A_4 + a_2a_3 \cos A_2A_3) = b_1b_2 \cos B_1B_2 + b_3b_4 \cos B_3B_4.$$

2704. Proposed by WILLIAM HOOVER, Columbus, Ohio.

A particle moves from rest under gravity down the arc of a parabola with the axis vertical and concavity upward; express the time to the vertex in terms of an elliptic integral of the second kind.

2705. Proposed by PAUL CAPRON, U. S. Naval Academy.

Find the area of a loop of the trochoid

$$x = \tfrac{1}{3}a(3\phi - \pi \sin \phi), \qquad y = \tfrac{1}{3}a(3 - \pi \cos \phi).$$

2706. Proposed by HARRIS F. MACNEISH, New York City.

Through a given point draw a straight line cutting a given straight line and a given circle, such that the part of the line between the given point and the given line may be equal to the part within the given circle.

2707. Proposed by S. A. COREY, Albia, Iowa.

Let a, b and c be the vector sides of a triangle. Construct another triangle with vector sides r, s and t, where

$$r = ma - dnb, \qquad s = na + (m + en)b.$$

Then prove that

$$(m^2 + emn + dn^2)(a^2 + eab \cos (ab) + db^2) = r^2 + ers \cos (rs) + ds^2,$$

where d, e, m and n are any scalar quantities; a, b, r and s are the tensors, or lengths, of the sides a, b, r and s, respectively; and $\cos (rs)$ is the cosine of the angle between r and s when placed coinitially.

2708. Proposed by WILLIAM HOOVER, Columbus, Ohio.

A uniform plank of length $2a$ and thickness $2h$ rests in equilibrium on a fixed rough horizontal cylinder of radius c, so that a vertical plane containing the dimension $2a$ and the center of gravity of the plank is at right angles to the axis of the cylinder; find the period of a complete small oscillation of the plank.

SOLUTIONS OF PROBLEMS.

492. (Algebra). Proposed by ARTEMAS MARTIN, Washington, D. C.

If two numbers, A and B, $B > A$, be selected at random, what is the probability that they have no common divisor?

SOLUTION BY WARREN WEAVER, Throop College of Technology, Pasadena, Cal.

The following treatment of this question is due to Tchebycheff, and has been taken from Fisher's *Mathematical Theory of Probability.*

If $p_2, p_3, \cdots, p_n$ denote respectively the probability that each of the primes $2, 3, 5, \cdots, n$ is not a common factor of A and B, then the probability that no prime number is a common factor is:

$$P = p_2 \cdot p_3 \cdot p_5 \cdot \cdots \cdot p_n \cdot \cdots \cdot \text{ad. inf.}$$

This follows from the multiplication theorem and the fact that the sequence of the prime numbers is infinite.

By dividing any integer by the prime n we obtain besides the quotient a certain remainder that must be one of the following numbers, namely,

$$0, 1, 2, 3, \cdots, (n - 1).$$

Each of the remainders may be considered as a possible event. The probability of obtaining 0 as a remainder is then $1/n$. This same quantity is the probability that n is a factor of B. The probability that both A and B *are* divisible by n is therefore $1/n^2$. The probability that the numbers A and B *do not* both have the prime factor n is then: